Female Reproductive Cycles and Hormones

The female reproductive system undergoes monthly cycles after the onset of puberty. These cycles prepare the body for potential pregnancy and involve coordinated changes in multiple organs, regulated by hormonal signals from the hypothalamus, pituitary gland, and ovaries.

Organs Involved in the Female Reproductive Cycle

- Hypothalamus
- Anterior pituitary gland
- Ovaries
- Uterus
- Uterine tubes
- Vagina
- Mammary glands

Hormonal Regulation

The **hypothalamus** secretes **gonadotropin-releasing hormone (GnRH)** , which is transported via the hypophyseal portal system to the anterior pituitary gland. In response, the pituitary gland releases two key gonadotropins:

- **Follicle-stimulating hormone (FSH)** – Stimulates the development of ovarian follicles and promotes estrogen secretion by granulosa cells.
- **Luteinizing hormone (LH)** – Triggers ovulation and stimulates the corpus luteum to produce **progesterone** and **estrogen** .

Ovarian Cycle

The **ovarian cycle** includes the **follicular phase** , **ovulation** , and the **luteal phase** . It is regulated by FSH and LH and involves the maturation of follicles, release of the secondary oocyte, and transformation of the follicle into the corpus luteum.

Follicular Development

- FSH stimulates the growth of several **primordial follicles** , but usually only one matures fully.
- The growing follicle undergoes the following changes:
    - Enlargement of the primary oocyte
    - Proliferation of granulosa (follicular) cells
    - Formation of the **zona pellucida**
    - Differentiation of the surrounding **theca folliculi** into:
        - Theca interna (vascular, hormone-producing)
        - Theca externa (fibrous capsule)

- Theca interna cells produce **estrogen** , **androgens** , and **follicular fluid** . Androgens are converted to estrogen by granulosa cells.
- Fluid-filled spaces merge to form the **antrum** , defining the follicle as a **secondary (vesicular) follicle** .
- The oocyte becomes surrounded by a mound of granulosa cells called the **cumulus oophorus** and is displaced to one side of the antrum.

Ovulation

- Mid-cycle, a surge in **LH** induced by rising estrogen levels triggers **ovulation** , typically 12–24 hours after the LH peak.
- The follicle bulges at the ovarian surface, forming a **stigma** .
- The follicle ruptures, releasing the **secondary oocyte** , surrounded by the **zona pellucida** and **corona radiata** (oocyte-cumulus complex).
- Enzymatic digestion and intrafollicular pressure assist oocyte expulsion.

Mittelschmerz (Mid-Cycle Pain)

Some women experience abdominal pain during ovulation, known as **mittelschmerz** , due to peritoneal irritation from follicular rupture and minor bleeding.

Anovulation

Failure to ovulate may result from insufficient gonadotropin secretion. Ovulation can be pharmacologically induced using agents like **clomiphene citrate** , which promotes FSH and LH release. This may lead to multiple follicular developments and increases the risk of **multiple gestation** and **spontaneous abortion** .

Corpus Luteum

- Following ovulation, the ruptured follicle transforms into the **corpus luteum** under the influence of LH.
- The corpus luteum secretes **progesterone** and **estrogen** , supporting endometrial preparation for implantation.
- If fertilization occurs:
    - **Human chorionic gonadotropin (hCG)** from the trophoblast maintains the corpus luteum.
    - The **corpus luteum of pregnancy** continues hormone production for approximately 20 weeks until the **placenta** takes over.
- If fertilization does not occur:
    - The corpus luteum regresses to form the **corpus luteum of menstruation** , which involutes to a fibrous **corpus albicans** .
    - Ovarian cycles persist until **menopause** .

Menstrual (Endometrial) Cycle

The **menstrual cycle** refers to cyclic changes in the **endometrium** in response to ovarian

hormones. It is divided into:

1. Menstrual Phase (Days 1–5)

- Shedding of the functional layer of the endometrium due to a decline in estrogen and progesterone.

2. Proliferative Phase (Days 6–14)

- **Estrogen** from developing follicles stimulates regeneration and proliferation of the endometrial lining.

3. Secretory Phase (Days 15–28)

- After ovulation, **progesterone** from the corpus luteum promotes endometrial gland maturation and secretion.
- The endometrium becomes receptive to blastocyst implantation.

If implantation does not occur, hormone levels fall, leading to **menstruation** , and the cycle begins again.